NON-PUBLIC?: N
ACCESSION #: 9204280268
LICENSEE EVENT REPORT (LER)

FACILITY NAME: McGuire Nuclear Station, Unit 2 PAGE: 1 OF 13

DOCKET NUMBER: 05000370

TITLE: A Unit 2 Reactor Trip Occurred From An Equipment Failure And Possible Installation Deficiency
EVENT DATE: 03/21/92 LER #: 92-04-0 REPORT DATE: 04/20/92

OTHER FACILITIES INVOLVED: McGuire, Unit 2 DOCKET NO: 05000370

OPERATING MODE: 1 POWER LEVEL: 63%

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR SECTION:
50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:
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Safety Review Group

COMPONENT FAILURE DESCRIPTION:
CAUSE: X SYSTEM: SJ COMPONENT: VP MANUFACTURER: M430
REPORTABLE NPRDS: Y

SUPPLEMENTAL REPORT EXPECTED: No

ABSTRACT:

On March 21, 1992, at 0609, Unit 2 experienced a Turbine Trip/Reactor Trip as a result of a Hi Hi Steam Generator level on Steam Generator 2C. Investigation of the Reactor Trip revealed a failure of the valve positioner linkage on valve 2CF-20. Valve 2CF-20 is the Steam Generator Main Feedwater Control valve for Steam Generator 2C. The valve positioner on valve 2CF-20 had broken which resulted in erroneous "valve closed" feedback to the valve controller. Therefore, the controller opened valve 2CF-20 further, which increased the feedwater flow to SG 2C, above the required level. The Unit was in Mode 1 (Power Operation) at 63 percent power prior to the trip. Notification was made to the NRC at 0650, on March 21, 1992. This event has been assigned a cause of Equipment Failure due to a possible installation deficiency, because it cannot be conclusively determined what caused valve 2CF-20 valve positioner to fail. The valve positioner was replaced and the unit

returned to Mode 1 on March 21, 1992, at 1557.

END OF ABSTRACT

EVALUATION:

Background

The Main Feedwater (CF) system EIIS:SJ! supplies feedwater at the required temperature, pressure and flow rate to the Steam Generators (SGs) EIIS:SG!, to maintain the proper vessel water levels with respect to Reactor EIIS:RCT! power output and Turbine (EIIS:TRB! steam requirements.

Valve 2CF-20 is one of four (one per SG) air diaphragm SG CF Control Valves EIIS:FCV!. In the automatic mode of operation, the valve is regulated by the SG Level Program and Feedwater Pump EIIS:P! Speed Control system. In the manual mode of operation, the valve is controlled by the Control Room Operator EIIS:NA! with the manual loader provided on the control board EIIS:MCBD!. The generation of a Hi Hi SG level initiates a Feedwater Isolation and Turbine Trip signal, and will cause the SG CF Control Valves to go fully closed.

Description of Event

On March 21, 1992, at approximately 0608, while implementing procedure PT/0/A/4150/21, Post-Refueling Controlling Procedure For Criticality, Zero Power Physics, and Power Escalation Testing, Operations (OPS) Control Room personnel received an annunciator EIIS:ANN! alarm EIIS:ALM! for SG 2C Steam/Flow Mismatch, Low Steam Flow and SG 2C Level Deviation. Valve 2CF-20, SG 2C CF Control Valve, indicated fully open. A Control Room operator immediately placed the valve in manual and closed the manual loader, however, valve 2CF-20 would not close. At 0609:33, OPS Control Room personnel received a SG 2C Hi Hi Level Turbine Trip alarm. This satisfied the 2 of 3 logic on 1 out of 4 SGs for Hi Hi SG level, causing a Turbine Trip/Reactor Trip. The logic also generated a Feedwater isolation signal which failed the SG CF Control Valves shut, including 2CF-20. OPS Control Room personnel immediately implemented procedure EP/2/A/5000/01 and 1.3, Reactor Trip Or Safety Injection, Reactor Trip. Unit 2 had successfully completed the 1992 End Of Cycle 7 refueling outage, and was in Mode 1 (Power Operation) at 63 percent power and increasing, at the time of the Unit trip. With the loss of CF pumps A and B, as a result of the Hi Hi SG level, Motor Driven Auxiliary Feedwater (CA) pumps automatically started as required, at 0609:34. When

reestablishing CF flow per enclosure 2 of procedure EP/2/A/5000/01, OPS Control Room personnel noted that prior to resetting the CF Isolation signal, it was necessary to close the Reactor Trip breakers, however, there was no reference made to this action in the procedure. Once the Reactor Trip breakers were closed, OPS personnel were able to reset the Feedwater Isolation signal. Additionally, Condensate Hotwell Pump (HWP) 2B failed to start on the load rejection signal. Work Request (WR) 146998 was written to investigate the failure. The failure of the HWP to start was attributed to a loose wiring connection which

was repaired. No-load conditions were achieved within the expected time frame of 30 minutes following the Reactor trip, with the exception of SG 2C level. At the time, SG 2C automatic level control program was attempting to recover from the level perturbation. Therefore, SG no-load narrow range (NR) level was achieved within an hour of the Reactor trip. All other system components functioned as required. Notification to the NRC was made at 0650, by the Shift Supervisor.

Investigation into the problem associated with valve 2CF-20 revealed that Instrumentation and Electrical (IAE) personnel repairing the valve, under WR 146995, suspect vibration and wear caused the failure of the Moore Model 72P315 valve positioner linkage, resulting in an erroneous fully closed indication to the controller. Based on this indication, the valve controller Bent the signal to open the valve. The valve positioner still showed valve 2CF-20 to be closed, so the controller continued to send the signal to open the valve further. The valve was actually opening, however, the valve controller was not receiving the feedback. Therefore, the controller continued to send the signal to open the valve until it reached 100 percent open. This, in turn, rapidly increased the level on SG 2C until it reached its Hi Hi level setpoint of 82 percent. During the time the level was increasing in SG 2C, the Control Room annunciators for steam/flow mismatch and level deviation alarmed. The Control Room Operator attempted to manually close valve 2CF-20, but the valve could not close with the existing failure. The level on SG 2C reached the setpoint, and the Turbine tripped on the Hi Hi SG Level signal. Instrumentation and Electrical (IAE) personnel replaced the valve positioner and Unit 2 was returned to Mode 1 at 1557, on March 21, 1992.

Conclusion

This event has been assigned a cause of Equipment Failure due to a possible installation deficiency because it cannot be conclusively determined what caused valve 2CF-20 valve positioner to fail. The failed valve positioner removed from valve 2CF-20 was forwarded to the Duke

Power metallurgical laboratory for failure analysis (Reference pages 7 thru 12). The results of the analysis states in part, "The most probable explanation for the wear was that the clevises on the ends of the linkage were not in the same plane when assembled." During the Unit 2 EOC 7 outage, maintenance activities were performed on valve 2CF-20. These activities included the normal Preventive Maintenance/Periodic Testing (PM/PT) performed by IAE personnel. While performing the PM/PT, IAE personnel noted a problem with the actuator to yoke connection. As a result of this observation, the actuator was replaced with a new actuator. This activity required the disassembly and reassembly of the valve positioner and associated linkage from the valve actuator. Disassembly and reassembly of the valve positioner and the associated linkage is an activity that is not normally performed. The only written guidance used by IAE personnel, when working on these valve positioners is provided in the manufacturers instruction manual. However, the IAE technicians assigned to work on the subject valve positioners are knowledgeable and have several years of experience

working with these valve positioners. When questioned about the assembly of the valve positioner and associated linkage, the IAE personnel involved were certain the assembly had been correctly performed. The "as found" condition of the valve positioner linkage and the connecting linkage could not be determined because the closing of the CF Control Valve on the Feedwater Isolation signal had distorted the linkages due to the valve positioner failure. Once the valve actuator was replaced, IAE personnel completed the PM/PT. Based on the evaluation of the available information, Component Engineering personnel concur with the results of the metallurgical analysis. The possibility exists that there was some misalignment of the valve positioner linkage, however, this cannot be definitively proven.

As a result of this event, IAE personnel will develop a procedure which addresses the set up and maintenance of the valve positioners associated with the SG CF Control Valves, incorporating as necessary, information from the manufacturers instruction manual. Operatio
s personnel will
enhance the Reactor Trip or Safety Injection procedures to include a step which addresses closing the Reactor Trip breakers prior to resetting the Feedwater Isolation signal.

A review of the Operating Experience Program (OEP) Database for the twenty-four months prior to this event revealed 4 events involving Reactor trips in which the cause was an Equipment Failure, and 1 event involving a Reactor trip with a cause of Possible Installation

Deficiency. This is therefore, considered to be a recurring problem. The events were documented on LERs 369/90-27, 369/91-01, 369/91-04, 370/91-07, 370/91-10, and 370/91-12. However, the corrective actions were specific to the particular event and would not have prevented this event from occurring.

This event is Nuclear Plant Reliability Data System (NPRDS) reportable.

There were no personnel injuries, radiation overexposures, or uncontrolled releases of radioactive material resulting from this event.

CORRECTIVE ACTIONS:

Immediate: 1) OPS personnel implemented Reactor Trip or safety Injection procedure.

Subsequent: 1) Emergency work request 146995 was initiated by OPS personnel to investigate and repair the problem associated with 2CF-20.

2) Emergency work request 146998 was initiated by OPS personnel to investigate and repair the problem associated with Condensate Hotwell Pump 2B.

3) The remaining valve positioners on Unit 2 and the valve positioners on Unit 1 were examined to make sure they were not experiencing the same or similar problem. There was no indication of wear or misalignment.

Planned: 1) IAE personnel will develop a procedure which addresses the set up and maintenance of the valve positioners associated with the SG CF Control Valves, incorporating as necessary, information from the manufacturers instruction manual.

2) OPS personnel will revise procedures EP/1,2/A/5000/1.3, Reactor Trip, enclosure 2, to include a step to close the Reactor Trip Breakers prior to resetting the Feedwater isolation signal.

SAFETY ANALYSIS:

During this event the valve positioner associated with valve 2CF-20

failed, causing the control circuitry to sense that valve 2CF-20 was closed. The control circuitry therefore, sent a signal to the valve positioner to open the valve to maintain flow to SG 2C. The control circuitry continued to send the signal sensing that the valve was still closed, however, valve 2CF-20 was actually opening. The control circuitry performed as designed. As the level in SG 2C reached the Hi Hi level setpoint, the annunciator alarms for steam/flow MisMatch and level deviation alerted OPS Control Room personnel who responded by placing the valve in manual and closing down on the controls, however, the valve did not close because of the positioner failure. The resulting Hi Hi level in the SG initiated a Feedwater Isolation and Turbine trip which initiated a Reactor trip since the Unit was above 48 percent power. This event is bounded by Feedwater System Malfunction Causing An Increase In Feedwater Flow found in Chapter 15 of the McGuire Final Safety Analysis Report.

Primary and secondary system no-load conditions necessary to achieve a safe shutdown were attained within 30 minutes after the Reactor trip with the exception of SG 2C level. At the time, SG 2C automatic level control program was attempting to recover from the level perturbation. Therefore, SG 2C no-load narrow range level was achieved within an hour of the Reactor trip. This event presented no hazard to the integrity of the plant.

There were no radiological consequences as a result of this trip, and the health and safety of the public and plant personnel were not affected as a result of this event.

ADDITIONAL INFORMATION:

Sequence of Events:

PTR - Post Trip Report
SSL - Unit 2 Shift Supervisors Logbook
WR -- Work Request
ER - Unit 2 Events Recorder
PR - Personnel Recollection
OAC - Operator Aid Computer

Date Time Event

3/21/92 0609:21 SG 2C Hi Narrow Range Level III. (OAC)

3/21/92 0609:30 SG 2C Hi Narrow Range Level IV. (OAC)

3/21/92 0609 OPS Control Room personnel placed valve 2CF-20 in manual and closed down on valve. (PR).

3/21/92 0609:33 SG 2C Hi Hi Level Turbine Trip. (ER,SSL)

3/21/92 0609:33 Reactor Trip. (ER, PTR, SSL)

3/21/92 0609:33 Loss of Both Feedwater Pumps.

3/21/92 0609:34 Auxiliary Feedwater Pumps automatically started.

(PTR)

3/21/92 ---- Work Requests generated by OPS personnel to investigate and repair valve 2CF-20 and 2B HWP.
(WR, PTR)

3/21/92 0650 OPS Shift Supervisor notified the NRC. (PR, SSL)

3/21/92 1130 Valve 2CF-20 repaired. (WR,SSL)

3/21/92 ---- 2B HWP repaired. (WR)

3/21/92 1557 Unit 2 entered Mode 1. (SSL)

DUKE POWER COMPANY

APPLIED SCIENCE CENTER

Metallurgical Analysis Report

Sample No.: 1303 Station: McGuire Unit: 2

Date: 4/9/92

Equipment Description:
Linkage from Valve Positioner on 2CF20

Background Information:
Failure of the valve positioner linkage resulted in a unit trip on 3/21/92. The linkage had been installed/adjusted two weeks prior to the failure. This feedwater regulator valve is located in the basement of the Turbine Building. The valve positioner Moore Model 72P315. A

failure analysis was requested.

Description/Macro-Examination:
Figure 1 is a diagram of the positioner mechanism with the linkage location shown. The portion of the linkage supplied for analysis is shown in Figure 2, with the nickel-plated brass clevis threaded into the shaft. The shaft operated with a second clevis threaded into the other end, also pinned. A nut allowed for adjustment to get both levis pieces in the same plane. A steel arm fit into the clevis gap and a steel pin passed through the hole, held in place by a steel cotter pin. A nickel-plated brass washer was located on the cotter pin side.

In Figure 2, a band of wear is visible along the shaft. This wear coincides with the location of another arm in the positioner box over the shaft. Nearer the damaged clevis, the wear was darker and not especially fresh; farther away, the damage was fresher and could have occurred on removal. The bend at the shaft end was reportedly created on removal. The damaged clevis was screwed very tightly into the shaft.

A great deal of material was missing from the failed clevis (Figure 3). Much of this material was recovered from the positioner box, mostly in the form of flat brass flakes with smeared surfaces. On the "top" side of the clevis (the visible side as installed), a groove was worn by the head of the pin. The portion around the pin opening which remained was circular. The path through the clevis was generally the width of the pin.

On the back side of the clevis, wear from the washer was evident (Figure 4). Wear at original washer location was uniform and not

particularly-deep. A series of steps of progressively deeper wear from the washer occurred as the pin moved outward through the clevis.

One tier of the clevis was cut off to reveal the wear pattern on the interior, where the clevis contacted the arm to which it was pinned. Wear to one side of the hole was heavier than to the other side (Figure 5). Wear on the interior of the top half (right in Figure 5) was heavier than wear on the bottom half.

The pin was coated with brass where it had contacted both tiers of the clevis (Figures 6 and 7). The coating was fairly uniform, including under the pin head. The pin surface was discolored a bluish-black where it passed along the gap in the clevis.

The washer had a uniform ridge of material pushed up around its inner diameter on the side which contacted the clevis (Figure 6). The inner diameter was 0.283", compared to 0.265" for a new washer. The opposite side was also worn from contact with cotter pin, but not nearly as severely (Figure 7). The wear had a rotational character and was generally uniform. The cotter pin had a small amount of brass smeared onto it.

Metallography:
The pin was sectioned to check for any surface irregularities. No unusual structural variations were found in the steel along the surface. Brass was smeared along the pin surface, in two differently-colored layers at some locations; the first
ayer might possibly have melted.
The pin material was a 400-series stainless steel, probably a free-machining grade such as 416.

Chemistry/Mechanical Testing:
No comparative hardness measurements were taken among the various components of the positioner. The materials involved were so intrinsically different in hardness (brass vs. steels) that variations in hardness for each would not have overcome the overall difference; that is, the softer brass would always be the metal to wear away.

Discussion:
The wear in the interior of the clevis was not uniform from side to side.

This observation implies that the plane of the clevis was not parallel to the plane of the positioner arm to which it was pinned.

The clearances involved in the pin/washer design were fairly small: the diameter of a new pin is 0.247", the hole in a new clevis is 0.253". A cocking of the clevis to one side would effectively reduce the diameter of the hole as seen by the pin and result in the pin rubbing against the edges of the hole.

movement of the linkage out of its normal plane of motion was likely a secondary occurrence, beginning after the pin began to seize in the clevis. Stepwise wear on the washer side of the clevis indicated that the pin cocked in its hole as it wore. Wear on top clevis interior was heavier than on the bottom interior, implying that a force with a component normal to the clevis was acting. The force may have resulted from the cocking of the pin in its hole. The linkage may have subsequently rubbed against or caught on the arm above it, resulting in

the wear seen on the shaft surface. Both arms had a lot of out-of-plane play in them, since they were also held by a pin, washer and cotter pin arrangement.

All wear observed was adhesive wear. In metal-to-metal contact, the softer metal is picked up and smeared onto harder metal. There was no evidence of abrasive wear, in which a hard foreign material (such as dirt) scores out the metal.

The discoloration of the pin at the clevis gap was attributed to heat generated by the adhesive wear.

The uniform coating of brass on the pin, the uniform wear on the washer, and the symmetrical ridge of metal on washer were indications that the pin and washer were rotating as wear occurred. This rotation was likely driven by the motion of the arm (s) against the pin, rather than by ambient vibration.

Conclusions:
The most probable explanation for the wear which occurred in the valve positioner was that the clevises on the ends of the linkage were not in the same plane when assembled. The clevis which wore through was probably slightly cocked to one side. The pin could not move freely in the hole, causing steady adhesive wear driven by the movement of the positioner arm and linkage. The harder steel pin eventually wore through the softer brass clevis.

TEXT PAGE 10 OF 13

Figure 1 "Diagram of linkage location in positioner box. Part #36 is the failed clevis, #11 the pin, #15 the shaft. (From Moore Products Co. Dwg. No., 118-222.)" omitted.

TEXT PAGE 11 OF 13

Figure 2 "Overall view of linkage section, lit so as to highlight band of wear along shaft (arrows). Bend in end at right was created during removal. Ma-2208." omitted.

Figure 3 "Detail of damage to clevis, "top" side as shown above. Circular groove left by head of pin before pin moved outward through clevis. Gauge = 1/16". Ma-2209." omitted.

TEXT PAGE 12 OF 13

Figure 4 "Detail of clevis, "bottom" side where washer rode. Wear became

progressively deeper as outward displacement of pin increased. Gauge = 1/16". Ma-2207." omitted.

Figure 5 "Wear on interior surfaces of clevis (cut open) from contact with arm in positioner box. Heaviest at lower right, lightest at upper left. G = 1/16". Ma-2213." omitted.

Figure 6 "Washer side which contacted clevis has a uniform ridge of material around its ID. Pin is uniformly smeared with brass and darkened at clevis gap. Ma-2210." omitted.

Figure 7 "Washer side toward cotter pin is also uniformly worn with a circular pattern. Brass has been smeared up under the head of the pin. Gauge = 1/16". Ma-2211." omitted.

Duke Power Company T.C. McMEEKIN
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April 20, 1992

DUKEPOWER

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

Subject: McGuire Nuclear Station Unit 2
Docket No. 50-370
Licensee Event Report 370/92-04

Gentlemen:

Pursuant to 10 CFR 50.73 Sections (a) (1) and (d), attached is Licensee Event Report 370/92-04 concerning a reactor trip. This report is being submitted in accordance with 10 CFR 50.73 (a) (2) (v). This event is considered to be of no significance with respect to the health and safety of the public.

Very truly yours,

T.C. McMeekin

TLP/bcb

Attachment

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